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| F. CHAU & ASSOCIATES, LLC 130 WOODBURY ROAD WOODBURY, NY 11797 | | | EXAMINER WALKE, AMANDA C | |
| | | | ART UNIT 1752 | PAPER NUMBER |
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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/787,368

Applicant(s)

KIM ET AL.

Examiner

Amanda C. Walke

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 October 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-33 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-33 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1, 5, 6, 11-17, and 22-33 are rejected under 35 U.S.C. 102(b) as being anticipated by Foster et al (6,054,248) in view of Gruber et al (4,276,136), Ryang et al (6,261,687), or Tamura et al (2004/0009428)

Foster et al teaches a thermally curable polymer composition comprising a hydroxyl-containing polymer and a polyfunctional isocyanate as a crosslinking agent, which is particularly useful in photolithographic coating of substrates. The thermally curable polymer composition may be dissolved in a solvent and used as an undercoat layer in deep UV lithography. Furthermore, the present invention further relates to a process for using the photolithographic coated substrate for the production of relief structures.

The reference teaches that “The thermally curable polymer composition also comprises a hydroxyl-containing polymer. Suitable examples of hydroxyl-containing polymers are polymers comprising monomer units selected from the group consisting of: cyclohexanol, hydroxyalkyl acrylate or methacrylate, hydroxycycloalkyl acrylate or methacrylate, hydroxyalkylcycloalkyl acrylate or methacrylate, allyl alcohol and the like. This invention also contemplates copolymers, terpolymers, etc. of the foregoing named polymers.

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Preferably, polymers comprising monomer units of cyclohexanol, hydroxyalkyl acrylate or methacrylate, and hydroxycycloalkyl acrylate or methacrylate have a number average molecular weight of about 9000 to 38,000, more preferably about 14,000 to 30,000 and most preferably about 18,000 to 22,000.

In addition, the thermally curable polymer composition may also further comprise monomer units of cycloaliphatic esters of acrylic or methacrylic acid. Suitable examples of monomer units of cycloaliphatic esters of acrylic or methacrylic acid are cyclohexyl acrylate or methacrylate, 4-tert-butylcyclohexyl acrylate or methacrylate, isobornyl acrylate or methacrylate and adamantyl acrylate or methacrylate and the like. The preferred monomer units of cycloaliphatic ester of acrylic or methacrylic acid are isobornyl acrylate or methacrylate.

Furthermore, the hydroxyl-containing polymer may further comprise aromatic monomer units, preferably styrene.

In a preferred embodiment, the thermally curable polymer composition comprises monomer units of (a) a cycloaliphatic ester of acrylic or methacrylic acid; (b) a sole aliphatic ester of acrylic or methacrylic acid consisting of hydroxyalkyl acrylate or methacrylate; and (c) a polyfunctional isocyanate, wherein the polymer has a number average molecular weight of about 9000 to 38,000, preferably about 14,000 to 30,000, more preferably about 18,000 to 22,000.

Other preferred copolymers useful in the thermally curable polymer composition are a copolymer of styrene and allyl alcohol with a weight average molecular weight of about 2000 to 20,000, preferably 2,000 to 10000; and a terpolymer of hydroxyalkyl acrylate or methacrylate, cycloaliphatic esters of acrylic or methacrylic acid and styrene with a number average molecular

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weights of about 9000 to 38,000, preferably about 14,000 to 30,000, more preferably about 18,000 to 22,000.

Examples of suitable hydroxyalkyl acrylate or methacrylates are hydroxymethyl acrylate or methacrylate, 2-hydroxyethyl acrylate or methacrylate, 3-hydroxypropyl acrylate or methacrylate, 4-hydroxybutyl acrylate or methacrylate, 5-hydroxypentyl acrylate or methacrylate, and 6-hydroxyhexyl acrylate or methacrylate and the like. Preferably, the hydroxyalkyl acrylate or methacrylate contains primary hydroxyl groups, although secondary alcohol groups or mixtures of primary and secondary alcohol groups may be used. Suitable examples of secondary alcohols are 2-hydroxy-2-methylethyl acrylate or methacrylate, 3-hydroxy-3-methylpropyl acrylate, 4-hydroxy-4-methylbutyl acrylate or methacrylate, 5-hydroxy-5-methyl propyl acrylate or methacrylate, and the like. The preferred hydroxyalkyl acrylate or methacrylate is 2-hydroxyethyl acrylate or methacrylate.

The thermally curable polymer composition of the present invention should not begin significant cross-linking until it reaches a temperature of about 50.degree. C. Significant cross-linking below 50.degree. C. may lead to gel formation at room temperature, which will reduce the composition's shelf life. Gel formation results in non-uniform coatings and linewidth variations across the substrate when the thermally curable polymer composition is used as an undercoat layer in microlithography.

Polymer 1 comprises about 60 to 80 mole % of isobomyl acrylate or methacrylate monomer units and about 20 to 40 mole % of 2-hydroxyethyl acrylate or methacrylate monomer units.

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Polymer 2 comprises about 30 to 40 mole % of isobomyl acrylate or methacrylate monomer units, about 10 to 30 mole % of 2-hydroxyethyl acrylate or methacrylate monomer units, and about 30 to 50 mole % of styrene monomer units.

Polymer 3 comprises about 39-60 mole % of styrene monomer units and about 40 to 61 mole % of allyl alcohol monomer units.

The polymerization of the polymers described above may be carried out by any suitable polymerization process such as free radical polymerization. The number average molecular weight of the Polymers 1 and 2 are about 9,000 to 38,000, preferably about 14,000 to 20,000, and more preferable about 18,000 to 22,000.

The present invention also relates to a photolithographic coated substrate comprising: a substrate, a thermally cured undercoat composition on the substrate, and a radiation-sensitive resist topcoat on the thermally cured undercoat composition.

The thermally cured undercoat composition comprises the thermally curable polymer composition comprising a hydroxyl-containing polymer and a polyfunctional isocyanate cross-linking agent that has been heated to form a cross-linked matrix. Any of the polymers described above may be used as the hydroxyl-containing polymer. Preferably, the hydroxyl-containing polymer is selected from Polymers 1, 2 or 3.

The present invention further relates to a process for using the photolithographic coated substrate for the production of relief structures comprising the steps of: providing the photolithographic coated substrate, imagewise exposing the radiation-sensitive resist topcoat to actinic radiation; and forming a resist image by developing the radiation-sensitive resist topcoat with a developer to form open areas in the radiation-sensitive resist topcoat. In addition, the

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thermally cured undercoat composition may be removed in the open areas of the developed radiation-sensitive resist topcoat by any suitable process such as oxygen plasma etching to form an image in the thermally cured undercoat composition.

One advantage of the thermally curable polymer composition is that it may be cured at a temperature of less than about 250 degrees C and for a time less than about 180 seconds. This make it particularly useful as an undercoat layer for a resist system where temperature and time constraints are important for commercial viability.

Both the undercoat and the radiation-sensitive compositions are uniformly applied to a substrate by known coating methods. The compositions are solubilized in an organic solvent and the coatings may be applied by spin-coating, dipping, knife coating, lamination, brushing, spraying, and reverse-roll coating. The coating thickness range generally covers values of about 0.1 to more than 10 microns, and more preferably from about 0.1 to 1.5 microns for the radiation-sensitive resist and about 0.3 to 3.0 microns for the undercoat layer. After the coating operation, the solvent is generally removed by curing or drying.

Suitable solvents for both the undercoat and topcoat radiation-sensitive compositions include ketones, ethers and esters, such as methyl ethyl ketone, methyl isobutyl ketone, 2-heptanone, cyclopentanone, cyclohexanone, 2-methoxy-1-propylene acetate, 2-methoxyethanol, 2-ethoxyethanol, 2-ethoxyethyl acetate, 1-methoxy-2-propyl acetate, 1,2-dimethoxy ethane ethyl acetate, cellosolve acetate, propylene glycol monoethyl ether acetate, propylene glycol methyl ether acetate, methyl lactate, ethyl lactate, methyl pyruvate, ethyl pyruvate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, N-methyl-2-pyrrolidone, 1,4-dioxane, ethylene

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glycol monoisopropyl ether, diethylene glycol monoethyl ether, diethylene glycol monomethyl ether, diethylene glycol dimethyl ether, and the like.

The radiation-sensitive resist topcoat of the present invention may be any suitable radiation-sensitive resist. It is typically a chemically amplified resist sensitive to radiation in the deep UV region.

The radiation-sensitive resist will also contain a photoacid generating (PAG) compound. The PAG compounds may be of any suitable type such as sulfonium or iodonium salts, nitrobenzyl esters, imidosulfonates esters and the like. Typically the PAG will be in an amount of about 1 to 10% based on the weight of the polymer.

For the production of relief structures, the radiation-sensitive resist is imagewise exposed to actinic radiation. The term 'imagewise' exposure includes both exposure through a photomask containing a predetermined pattern, exposure by means of a computer controlled laser beam which is moved over the surface of the coated substrate, exposure by means of computer-controlled electron beams, and exposure by means of X-rays or UV rays through a corresponding mask. The imagewise exposure generates acid in the exposed regions of the resist which cleaves the acid labile groups resulting in a polymer which is aqueous soluble. Typically, after imagewise exposure, the chemically amplified resist will be subjected to a post exposure heating treatment that virtually completes the reaction of the photoacid generator with the acid labile groups.

After imagewise exposure and any heat treatment of the material, the exposed areas of the top radiation-sensitive resist are typically removed by dissolution in a aqueous developer. The choice of the particular developer depends on the type of photoresist; in particular on the

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nature of the polymer resin or the photolysis products generated. The developer can comprise aqueous solutions of bases to which organic solvents or mixtures thereof may have been added. Particularly preferred developers are aqueous alkaline solutions. These include, for example, aqueous solutions of alkali metal silicates, phosphates, hydroxides and carbonates, but in particular of tetra alkylammonium hydroxides, and more preferably tetramethylammonium hydroxide (TMAH). If desired, relatively small amounts of wetting agents and/or organic solvents can also be added to these solutions.

The radiation-sensitive resist used for the bilayer process described above will typically contain silicon or have silicon incorporated into the resist after development. After images are formed in the radiation-sensitive resist, the substrate will be placed in an plasma-etching environment comprising oxygen so that the underlayer coating will be removed. The silicon incorporated in the radiation-sensitive resist forms silicon dioxide when exposed to an oxygen plasma and protects it from being etched so that relief structures can be formed in the undercoat layer.

After the oxygen plasma step, the substrate carrying the bilayer relief structure is generally subjected to at least one further treatment step which changes the substrate in areas not covered by the bilayer coating. Typically, this can be implantation of a dopant, deposition of another material on the substrate or an etching of the substrate. This is usually followed by the removal of the resist coating from the substrate typically by a fluorine/oxygen plasma etch. (column 4, line 1 to column 8, line 16).

The reference teaches that the underlayer and resist layer may be baked or cured after coating by any known method. But the reference fails to specifically teach ebeam curing.

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Gruber et al, Ryang et al, and Tamura et al all teach that similar polymeric curable compositions are cured by ebeam.

Given the teachings of the reference that clearly disclose polymers meeting the instant claim limitations employed in an undercoat for a bilayer resist and a method of forming a pattern using the same as described by the instant invention, it would have been obvious to one of ordinary skill in the art to prepare the material of Foster et al choosing to employ ebeam to cure the thermally curable underlayer given that it is taught to be conventional by Tamura et al, Ryang et al, and Gruber et al.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 2-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Foster et al in view of Ryang et al, Gruber et al, or Tamura et al in view of Schaedeli et al (6,146,793).

Foster et al has been discussed above, and while the reference clearly anticipates the use of the methacrylate polymer with an aromatic polymer (styrene), it fails to teach the use of a novolac resin.

Schaedeli et al disclose a bilayer system for use in 193 nm photolithography. The invention also relates to radiation sensitive photoresist compositions comprising a new terpolymer and to a process for the lithographic treatment of a substrate by means of the photoresist composition, as well as a process for the production of electronic components using

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the new terpolymer in a radiation sensitive photoresist top layer coating in a 193 nm lithographic system.

The reference further teaches that “ any suitable film-forming organic polymers can be used as the film-forming organic material for the first coating (undercoat layer) with the use of the multilayer technique. Particularly preferred are phenolic resins, particularly novolak resins, such as formaldehyde cresol or formaldehyde phenol novolaks, polyimide resins, poly(meth)acrylate resins and styrene-allyl alcohol copolymer resins, the latter being preferred. “

Given the teachings of the reference, it would have been obvious to one of ordinary skill in the art to prepare the material of Foster et al choosing to employ any phenolic resin in the undercoat layer such as a novolak resin given the teaching of Schaedeli et al that it is conventional, with reasonable expectation of achieving a material having high resolution.

5. Claims 6-10 and 17-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Foster et al in view of Ryang et al, Gruber et al, or Tamura et al in view of Wong et al (6,319,655).

Foster et al has been discussed above, and while the reference teaches that the material is suitable for exposure at the 193 nm region, the reference fails to teach or suggest suitable exposure doses.

Wong et al disclose a resist that typical UV exposure doses fall within the limitations of the instant claims, as do the typical electron beam exposures (column 7, line 45 to column 8, line 64).

Given the teachings of the reference it would have been obvious to one of ordinary skill in the art to prepare the material of Foster et al using the exposure doses taught by Wong et al

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which are conventional doses, with reasonable expectation of achieving a material having high resolution.


Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Greenblatt et al (2003/0069363), Smetana et al (2002/0086161), and Breyta et al (2004/0048194) are cited for their teachings of similar curing methods.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Amanda C. Walke whose telephone number is 571-272-1337. The examiner can normally be reached on M-R 5:30-4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Cynthia Kelly can be reached on 571-272-1526. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Amanda C Walke
Examiner
Art Unit 1752

ACW
December 22, 2005